REACHING YOUR LIMITS

Objectives:

Students will:

- describe the relationship between water quality and water treatment
- define the ratio of one to a million.

Materials:

- Two 100 or 250 ml beakers
- Water mixed with blue food coloring
- Clear water
- 10 ml graduated cylinder
- 3x5 cards
- Lightweight wood or metal poles, broomsticks, or metersticks
- Ruler
- Index cards
- 1. Review the background information on water treatment and water quality standards in the US and how health and environmental agencies work together to monitor water. There is information at www.epa.gov/safewater/standards.html (this is the EPA's homepage for about contaminants in water) www.epa.gov/OGWDW/ or www.epa.gov/safewater.mcl.html (listing the standards for organic and inorganic contaminants. These standards are listed as milligrams per liter (mg/L)⁴, which is approximately equal to parts per million.). There is also the EPA Drinking Water Hotline at 1-800-426-4791 where you can get the phone number and address of your state's contact. EPA also has some great student pages that explain water quality. You may need to do some searching for specific information. These EPA sites are: www.epa.gov/students/ground water primer.htm www.epa.gov/students/water on tap.htm.
- 2. Scientists measure and report water contaminants in parts per million (ppm) and parts per billion (ppb) because very small amounts of contaminants can cause large problems. For instance, people can smell petroleum products in water at concentrations as low as 10 parts per billion. Have students discuss what one billion is. Have them determine how many years one billion seconds is. One billion seconds equals approximately 32 years.
- 3. Show students a glass of water. Ask how they know it is safe to drink. Have them list things they would like to know about the water before they drink it. Would they drink water from a bottle? From a faucet? From a stream? From a pond?
- 4. Measure 100ml of water mixed with several drops of blue food coloring and state that this represents polluted water. Ask if anyone would want to drink it.
- 5. Take 10ml of the polluted water and put in into 90ml of clear water. This is one part per 10. Would they drink it? What if they were thirsty or in the desert? Take 10ml of this solution and add it to 90ml clear water. (Put 90ml of solution into see through cup for comparison and reuse the beakers.) This represents 1 part per 100. Would they drink the water now? Dilute the polluted water one more time, 10ml to 90ml clear water,) putting

- the 90ml of the second solution into a see through cup for comparison.) This is now 1 part per thousand (ppt). Repeat this three more times until you get to 1 part per million (ppm). Would they drink the water now? Why or why not?
- 6. Begin a discussion about why water is treated. What kinds of things end up in water and is it necessary to clean it? It is impossible to clean water all the way, so standards have been established to recognize acceptable levels of contaminants. At acceptable levels many contaminants can be present in water without being harmful.
- 7. Bring this discussion to the students' perspective. Look at the students to see how many are wearing jeans. Let's say it is 8 out of 25. That makes the concentration of jeans 8 parts per 25. What if there was a rule that no more than 3 people each day could wear jeans because a standard had been set?
- 8. Have the students create a system to meet that standard every day. Can this standard be universally applied? What if some students only had jeans to wear or what if some students would have to wear shorts or skirts all the time? Are there places where the technology is not present and the water can not be cleaned? Are there some pollutants that need more regulation than others because they are more harmful?
- 9. Why is it important to have clean water? People need it, does anything else? Ask the students to list other things affected by polluted water (animals, plants, speleothems, air quality, cave life, etc).
- 10. Have the students brainstorm a list of things can be done to keep water clean and a list of things that people do that pollute water. Write these on the board in two categories.
- 11. If time allows, play "water treatment limbo" with the broomstick. Have each student write one of listed items on an index card. Two students will hold the ends of the broomstick and are a treatment plant. The stick will symbolize the pollution level and the students going under it are the water. Before students go under the stick, have him or her read his or her card. If the card helps clean water, move the stick up 3 inches, if it pollutes the water, move the stick down three inches. Put the card back into the deck and shuffle. When the students can no longer get under the bar, tell them this means that the treatment plant is taking in water that is too polluted for the plant standards. They will have to come up with a new solution for cleaning the water.

Discussion:

- Does this happen in real life?
- What do treatment plants do when there is too much water to treat?
- Do they keep the water or do they dump it into the nearest water source?
- Is it possible to clean all water?
- What would happen to the cave environment if things like parking lot runoff of gasoline and oil were getting into a cave?
- Can animals build up a tolerance to unclean water? What are examples? (Dogs can drink out of toilets!)
- Is there any way nature works to clean water? (Sand, cattails, etc) What can we do to help?

